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A DIVISION OF NORTHERN TELECOM, INC.

INSTRUCTION MANUAL

MODEL TTS-26BXS
SF SIGNAL SYSTEM TEST PANEL

No. A0026-58-600 ISSUE 1 DATE AUG 1967

PRINTED IN U.S.A.

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NORTHEAST ELECTRONICS CORPORATION
Airport Road
Concord, New Hampshire

MODEL TTS 26BXS SF SIGNAL SYSTEM TEST PANEL

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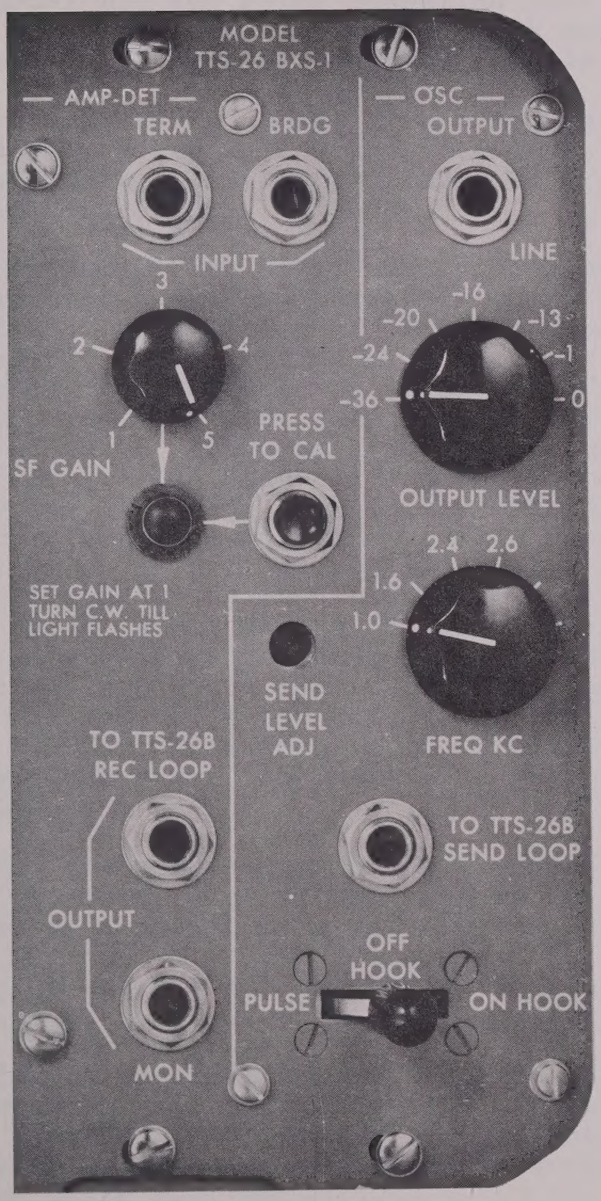

MODEL
TTS-26 BXS-1
AMP-DET
TERM
BRDG
INPUT
OSC
OUTPUT
LINE
3
2
4
1
5
SF GAIN
PRESS
TO CAL
-16
-20
-13
-24
-1
-36
-0
OUTPUT LEVEL
SET GAIN AT 1
TURN C.W. TILL
LIGHT FLASHES
2.4
2.6
1.6
1.0
SEND
LEVEL
ADJ
FREQ KC
TO TTS-26B
REC LOOP
TO TTS-26B
SEND LOOP
OUTPUT
OFF
HOOK
PULSE
ON HOOK
MON

FIG-1

MODEL TTS 26BXS SF SIGNAL SYSTEM TEST PANEL

OPERATING INSTRUCTIONS

1.0 GENERAL

1.01 The Model TTS 26BXS SF Signal System Test Panel, when used with the Model TTS 26B Pulse Signaling Test Set, extends the capabilities of the basic pulse signaling test set to include the sending and receiving of single frequency signals.

1.02 The Model TTS 26BXS is packaged in a modular form designed to mount as an accessory unit within the cover of the Model TTS 26B. Special assemblies are also available to provide for rack mounting when required.

1.03 This unit can be electrically subdivided into two separate circuits, the first of which provides a means to generate SF tones, i.e., 2400 and 2600 cps. The keying of these tones is normally under direct control of the send circuits within the pulse signaling test set. The output of the send section is equipped with an output level attenuator ranging in steps from 0 to -36 dbm, and is designed to match a 600 ohm circuit. Frequencies available are fixed at 1, 1.6, 2.4, and 2.6 KC. Space has been allowed for two additional frequencies, should they be required. The second section contains the amplifier and detector circuits to transform the received SF signaling into DC pulsing, which in turn is applied to the receive circuit of the pulse signaling test set, thus providing a direct indication of the % break and speed in pps of the SF signaling received. The input circuit of the amplifier detector is equipped with two input jacks, one of which is 600 ohm terminating and the other high impedance bridging. The output of the detector circuit is also equipped with two jacks, one for connecting to the receiving circuit of the basic test set and the other for monitoring purposes, i.e., to operate a pen recorder, etc.

1.04 The 1000 cps frequency included in the send section is provided for use where a reference tone is required. This can be applied either on a steady or a pulse basis, depending on the position of the key switch. This feature can be especially useful where activating or testing the Model TTS 40A Loop Around Unit, which requires a 1 KC tone pulsed at a 20 cycle rate.

1.05 A key switch is provided for supervision purposes. The ON HOOK position of this switch applies a continuous SF tone to the circuit, the OFF HOOK position removes the tone from the circuit, and the PULSE position connects the keying circuits to the output of the basic test set.

1.06 This unit is designed to operate from a well filtered 48 volt DC source; current requirements are approximately 120 ma. It is 8" h x 4" w x 3 3/4" d.

2.0 PERFORMANCE DATA

2.01 Specifications - Send Section

Send Frequencies:

1	1000 cps
2	1600 cps
3	2400 cps
4	2600 cps

Output Level: Variable in the following steps:

0 dbm, -1 dbm, -13 dbm, -16 dbm, -20 dbm, -24 dbm, -36 dbm

Output Impedance: 600 ohms, balanced, DC blocked

Frequency Stability: Better than 1% from 50°F to 100°F

Level Stability: Better than .25 db from 50°F to 100°F

Distortion: Less than 1% at any harmonic component

Attenuator Accuracy: Better than .20 db

2.02 Specifications - Receive Section

Receive Input Impedance, Terminating: 600 ohms DC blocked

Receive Input Impedance, Bridging: >50 K DC blocked

Sensitivity: The unit can be calibrated to operate from levels down to approximately -40 dbm

Receive Output, Dry Contacts, Reed Relay: These contacts are not designed to drive high current or inductive circuits

Spark Suppression: None provided

Duty Cycle: Continuous for both send and receive sections

3.0 CIRCUIT DESCRIPTION

Send Section

3.01 The send section of the TTS 26BXS consists of a transistorized oscillator keying unit and associated frequency determining networks, attenuator circuit, and output circuit. The circuit diagram to which the following description applies is shown in Figure 3.

3.02 A bridged-T type of R-C oscillator, consisting of three transistor stages, is used. The first two transistors are directly coupled from the collector of Q1 to the base of Q2. The positive feedback path is completed from the emitter of Q2, back through a blocking condenser and a tungsten lamp utilized for level stabilization, to the emitter of Q1. A part of the emitter resistance of Q1 has been made variable to allow setting the correct amount of positive feedback necessary for stable operation.

3.03 A negative feedback which is greater than the positive feedback is supplied to the base of Q1 through a null selective network and an emitter follower. At its tuned frequency the selective bridged-T null network decreases the negative feedback sufficiently to permit oscillation to occur at the desired frequency, which is determined by the R-C values employed within the network. This frequency determining network consists of capacitances C3 and C4, and the resistor associated with frequency selector switch S1.

3.04 The keying circuit consists of transistor stage Q4, which is operated as an emitter follower. The base of Q4 is coupled to the emitter of Q2 through resistor R7. Resistor R7 provides adequate decoupling to allow the keying stage to be turned on and off without adverse effects to the oscillator. Keying is accomplished by applying ground to or removing ground from the base of Q4; capacitor C6 provides DC blocking for the keying circuit. The output signal of the oscillator keyer unit, appearing across emitter load resistor R15 is coupled to the primary winding of output transformer T1 through DC blocking capacitor C7. Resistor R3 and capacitor C2 in the secondary winding of the output transformer provide for the impedance buildout and DC blocking of the output circuit.

3.05 The output level of the oscillator keyer unit is controlled by the setting of OUTPUT LEVEL switch S2. Depending on the setting of S2, a portion of the AC voltage appearing at the base of Q4 is shunted to ground to provide the exact output level to correspond to the setting of S2.

3.06 Key switch S4 is provided to establish ON and OFF HOOK supervision. In the ON HOOK position of S4, pulsing circuits connecting to J2 are removed from the keying circuit of Q4. This establishes an on hook or steady tone condition on the circuit. The OFF HOOK position of S4 disconnects the pulsing circuit applied to J2 and in addition applies ground to the keying circuit

of Q4, thus establishing an off hook or no tone condition. The PULSE position of S4 switches the keying circuit of Q4 through to the pulsing circuits connected into J2. In operation, J2 is normally patched to the SEND LOOP jack of the TTS 26B.

3.07 Resistors R1 and R2 provide voltage division, capacitor C1 provides decoupling, and zener diode CR1 provides regulation of the battery voltage. Zener diode CR1 regulates at approximately 24 volts. This regulation is necessary in order to achieve a uniform envelope of the SF tone output while being pulsed.

3.08 It is to be noted that resistor R15, associated with the output circuit of Q4, has been strapped. This same oscillator keyer card is used in numerous other applications in which some require the use of R15; however, this application does not require it, and it is therefore strapped out of the circuit.

Detector Section

3.09 The major portion of the detector circuitry is contained on a printed circuit card; this card is mounted perpendicularly to the panel toward the lefthand side when viewing the unit from the front. A schematic diagram of the detector section is shown in Figure 2.

3.10 The receive signal is coupled to amplifier stage Q1 via input transformer T1. Capacitors C1 and C12 provide DC blocking for the input circuit. There are two jacks associated with the input, J1 and J2. Capacitor C13 and resistor R22 are normally connected across the tip and ring of J1 to provide the 600 ohm input termination. BRIDGE jack J2 is equipped with interrupter contacts to remove this termination when jacking into J2. Variable resistor R1, connected across the secondary of T1, serves as the calibration control. The arm of this control is coupled to the base of amplifier stage Q1 through DC blocking capacitor C2. The output signal of amplifier stage Q1, which appears across collector load resistor R5, is coupled to the base of the second amplifier stage, Q2, through DC blocking capacitor C4. The output of this stage is, in turn, coupled to the third amplifier stage, Q3, through resistor R10 and DC blocking capacitors C5 and C6. Diodes CR2 and CR3 serve as a varistor or clamping circuit to supply the AGC required to prevent amplifier stage Q3 from being driven into saturation. This circuit is necessary in order to insure that the % break of the DC output is equal to that of the incoming SF signaling.

3.11 The output of amplifier stage Q3 is coupled to transformer T2 through DC blocking capacitor C7. The secondary winding of T2 connects to diodes CR4-CR7, which serve as a full wave bridge rectifier. The DC output of this bridge is connected to the base of Q4. Resistor R17, which connects between the base of Q4 and negative battery, provides bias to retain Q4 in an on condition. Q4, being

normally in an on condition, holds relay K1 in its collector circuit in an operated condition. Thus, with no signal input, the contacts of relay K1 are closed or in a so-called off hook condition. When an SF tone is applied to the input of the detector unit, a positive voltage is developed across the output of the bridge rectifier, which in turn turns Q4 off to release relay K1.

3.12 The calibration required to normalize the detector circuitry to the input level is accomplished through the operation of CAL switch S3 and its associated circuitry. S3, in the operate position, connects the contacts of relay K1 to the tip and ring of jacks J3 and J4. This tip and ring circuit is normally extended to the receive circuit of the associated TTS 26B. MON jack J4, in parallel with J3, is provided for the operation of an external recorder such as a Brush or pen recorder. The CAL position of S3 switches the contacts of relay K1 to calibration lamp PL1. Another set of contacts on S3 applies ground to R11 which is in the base circuit of amplifier stage Q3. This shunts a portion of the AC voltage appearing at this point to ground. The normal calibration procedure is to advance SF GAIN control R1 to a point where relay K1 just starts to follow the incoming SF pulsing. At this point CAL switch S3 is moved to the operate position, returning the relay contacts to the output jacks and removing ground from the AC shunting resistor R11. The removal of ground from resistor R11 increases the output of amplifier stage Q3 several db above the threshold point; thus, proper level normalization is achieved.

3.13 Capacitor C11 and resistor R20 and R21 provide voltage division and decoupling for the battery circuit. Diode CR1 provides protection should improper polarity of the battery circuit be applied. Resistors R18 and R19 serve as a voltage divider for the relay driving stage. Diode CR8 across the winding of relay K1 protects transistor Q4 from high voltage spikes developed across the coil of relay K. Capacitors C3 and C8 provide AC bypass for the associated amplifier stages. A relatively high degree of 60 cycle attenuation is achieved through the selection of the values for the various coupling capacitors. It is therefore important to keep with the same values shown on the schematic, should it become necessary to replace any of these coupling capacitors.

4.0 CONTROLS, SWITCHES, AND JACKS

4.01 The following controls, switches, and jacks are provided on the TTS 26BXS:

1. OUTPUT LEVEL: Provides a means for setting the SEND level. These send levels range from 0 to -36 dbm, depending on the setting of this switch.

2. FREQ KC: Provides for the selection of the send frequency.

3. Supervision Key Swtich: Establishes on hook, off hook, or normal pulsing under control of the TTS 26B send circuits.

4. CAL switch (push button): Provides the changeover circuitry to shift from normal to calibration condition.

5. SEND LEVEL ADJ Control (recessed behind the front panel): This control provides a means for setting the level of the send circuits to agree exactly to the reading of the OUTPUT LEVEL control. This adjustment is made with the OUTPUT LEVEL control in the "0" position.

6. Pilot Lamp (associated with the calibration circuits): This lamp will flash when sufficient gain has been inserted by the operation of the SF GAIN control to allow the output stage to follow the incoming SF pulsing.

4.02 The following jacks are provided:

1. TO TTS 26B SEND LOOP: For connecting the oscillator keyer input circuits to the TTS 26B send circuits.

2. OUTPUT: Provides for the connection of the line circuit under test to the output circuits of the oscillator.

3. TO TTS 26B REC LOOP: Provides for the connection of the TTS 26B receive circuits to the output of the SF detector circuit.

4. MON(monitor): This jack is in parallel with the TO TTS 26B REC LOOP jack for the operation of an external recorder when required.

5. INPUT-BRDG (bridging): Provides for the connection of the line circuit to the input of the detector circuits on a bridging basis.

6. INPUT-TERM (terminating): Provides for the connection of the line circuit to the input of the detector section on a 600 ohm terminating basis.

5.0 OPERATION - Send Section

5.01 To send SF pulses using the TTS 26B with the TTS 26BXS, proceed as follows:

1. On the TTS 26B turn the left hand turn button to SEND RT ON 1&2 and the right hand turn button to SPARK SUP OFF.

2. Set the RECEIVE switch for the desired receiving condition and the SEND switch at SND LOOP-REC LOOP.

3. Plug a 2-conductor cord (T&S) with a 310 type plug into the appropriate 48 volt jack of the set. (This should precede connection to battery to avoid blowing a fuse.) Then connect the other end to 48 volt office battery (40 to 55 volts).

4. Turn the PULSES PER SEC switch to the desired pulse rate. LINE (E) and DROP (M) lamps should light.

5. Set the METER CIRCUIT switch at % BREAK DIRECT.

6. Operate the TEST SEND key to SEND OSC. The TWD-L and TWD-D keys may be operated to establish the desired supervisory conditions.

7. Plug in and lock in the connector plug on the cord from the accessory cover to the EXT ADAPT socket.

8. With a 2-conductor (T&R) cord having 310 type plugs on both ends patch from the TO TTS 26 SEND jack to the TTS 26BXS to either #1 or #2 LOOP SEND jack.

9. On the TTS 26BXS set the FREQ KC switch at the desired frequency and the OUTPUT LEVEL switch at the desired level. The latter is calibrated in db. (If it is desired to check the calibration of this output, adjustment may be made by turning the SEND LEVEL ADJ trimmer screw as necessary.)

10. Turn the FUNCTION switch of the TTS 26B to CAL METER and adjust the METER CAL control to read 0 on the meter scale.

11. Turn the FUNCTION switch to ADJ % BREAK and adjust the ADJ % BREAK control to obtain the desired % break.

12. Turn the FUNCTION switch to SEND AND REC.

13. To send SF pulses move the key switch on the TTS 26BXS to the PULSE position. The OFF HOOK position of the key switch establishes a "no tone" condition and the ON HOOK position a "steady tone" condition.

14. Pulses now are available at the desired rate and level with a cord having a 310 type plug plugged into the LINE OUTPUT jack of the TTS 26BXS. If these are used to pulse an SF signaling converter, the DC output of this converter may be received and measured at the appropriate receiving jack, with the RECEIVE switch in the proper position.

6.0 OPERATION - Receive Section

6.01 To measure SF pulses using the TTS 26B with the TTS 26BXS, proceed as follows:

1. On the TTS 26B turn the left hand turn button to the RT ON 1&2 position and the right hand turn button to SPARK SUP OFF.

2. Set the RECEIVE switch at REC LOOP and, if pulses are to be sent out simultaneously (as into an SF signaling converter), set the SEND switch for the desired sending condition.

3. Plug a 2-conductor cord (T&S) with a 310 type plug into the appropriate 48 volt jack of the set. (This should precede connection to battery to avoid blowing a fuse.) Then connect the other end to 48 volt office battery (40 to 55 volts).

4. Turn the PULSES PER SEC switch to the desired pulse rate. LINE (E) and DROP (M) lamps should light.

5. Set the METER CIRCUIT switch at % BREAK DIRECT..

6. If the same set is being used to send and receive pulses, operate the TEST SEND key to SEND OSC, otherwise operate the TEST SEND key to TEST L&D. The TWD-L and TWD-D key may be operated to establish desired supervisory conditions.

7. Plug in and lock in the connector plug on the cord from the accessory cover to the EXT ADAPT socket.

8. With a 2-conductor cord (T&R) having 310 type plugs on both ends patch from the TO TTS 26 REC LOOP jack of the TTS 26BXS to the REC LOOP jack of the TTS 26B.

9. Turn the FUNCTION switch of the TTS 26B to CAL METER and adjust the METER CAL control to read 0 on the meter scale.

10. Turn the FUNCTION switch to ADJ % BREAK and adjust the ADJ % BREAK control to the desired % break if pulses are to be sent out simultaneously, otherwise omit this setp.

11. Turn the FUNCTION switch to SEND AND REC.

12. Patch the circuit from which pulses are to be received to either the BRDG or TERM INPUT jack of the TTS 26BXS, whichever is desired.

13. Turn the SF CAL control of the TTS 26BXS completely counter clockwise; then, holding the PRESS TO CAL button depressed, advance the SF CAL control clockwise until uniform pulses are observed on the SF CAL lamp.

14. Release the PRESS TO CAL button and read the received % break on the meter of the TTS 26B.

7.0 MAINTENANCE AND TROUBLE SHOOTING

7.01 The TTS 26BXS does not require any routine maintenance other than an occasional check of the oscillator send level. It is therefore not recommended that the unit be removed from the case until such time as malfunctions occur. Extreme care should be exercised when removing or replacing this unit within its case. The connecting cables should be carefully routed to insure that there will be no interference between the cable and other parts of this or other units within the cover.

7.02 The send level of the oscillator section can be verified by connecting the output of the send section to a transmission measuring set equipped with a 600 ohm input. With the OUTPUT LEVEL control in the 0 position and the key switch in the ON HOOK position a reading of 0 level should be observed on the measuring Set. Calibration of this level, when required, is accomplished by turning the SEND LEVEL ADJ control (screwdriver adjustment recessed in rear of front panel) to obtain the required 0 level.

7.03 The basic test equipment for servicing this unit, if malfunctions occur, should include an oscilloscope and a VTVM. Servicing should be restricted to personnel trained in servicing of transistorized circuits. The circuit description of this unit also serves as a trouble shooting procedure.

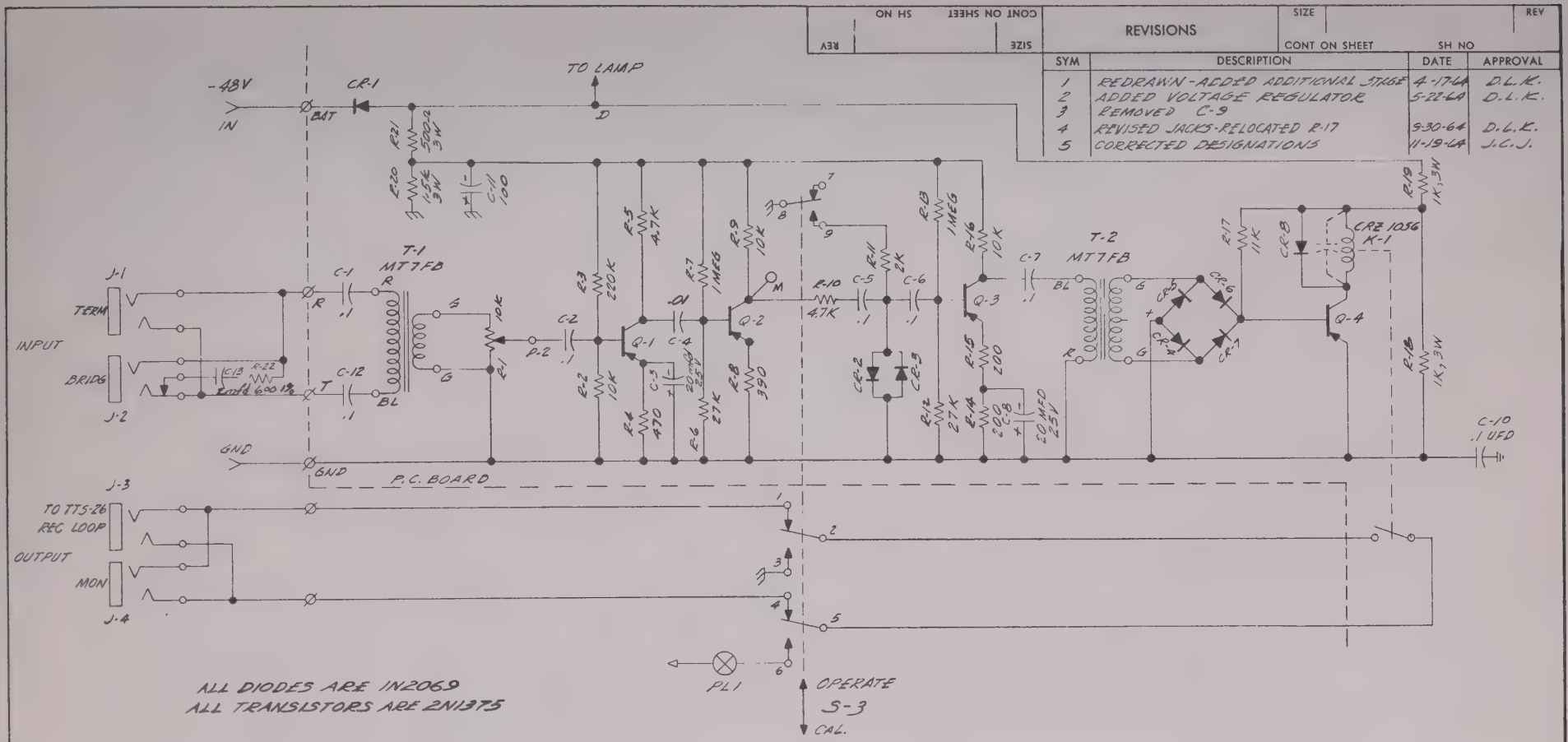
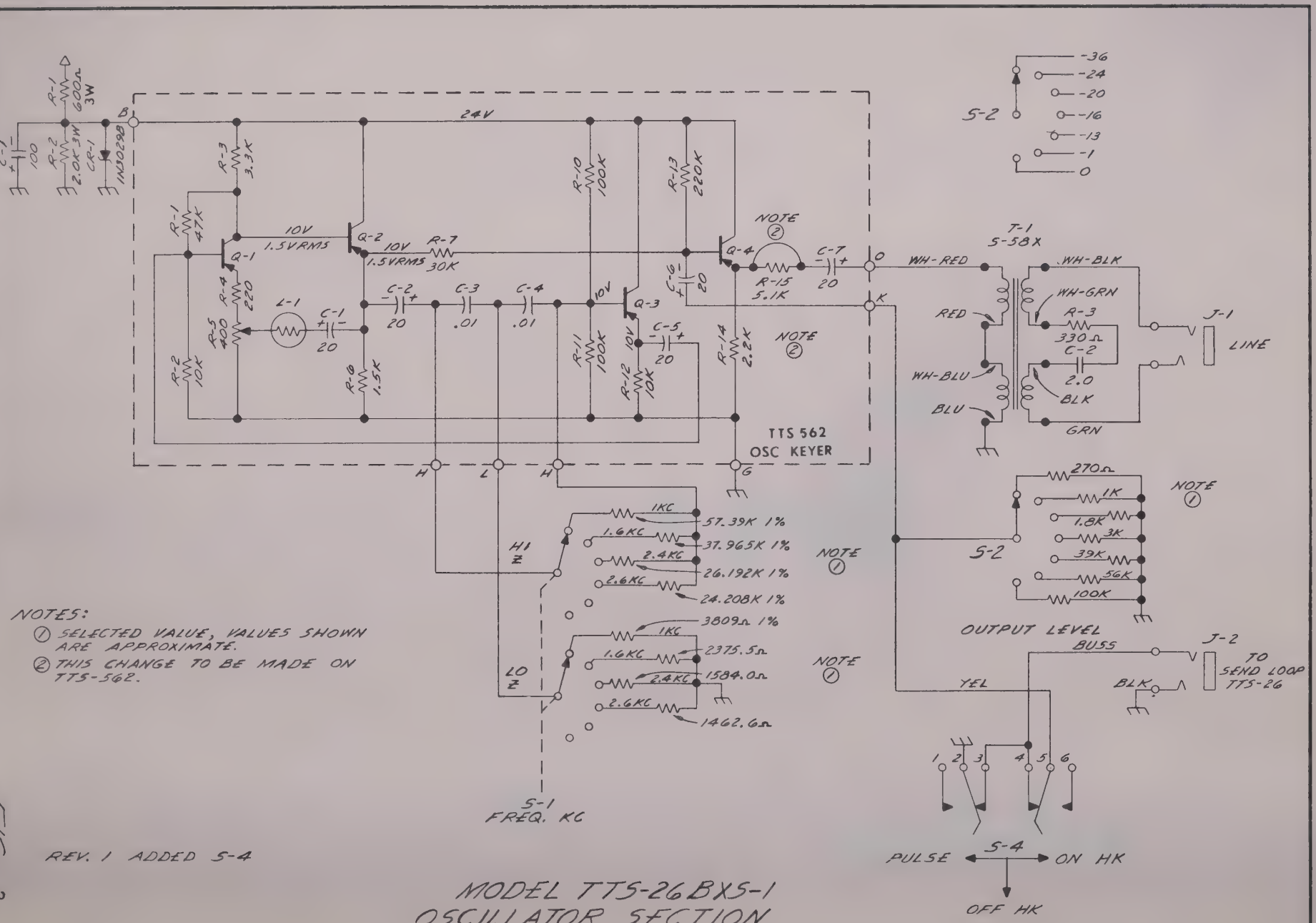

REVISIONS
SIZE
REV
CONT ON SHEET
SH NO
SYM | DESCRIPTION | DATE | APPROVAL
1 REDRAWN - ADDED ADDITIONAL STAGE 4-17-64 D.L.K.
2 ADDED VOLTAGE REGULATOR 5-22-64 D.L.K.
3 REMOVED C-9
4 REVISED JACKS - RELOCATED R-17 9-30-64 D.L.K.
5 CORRECTED DESIGNATIONS 11-19-64 J.C.J.
-48V
IN
BAT
CR-1
TO LAMP
D
R21 500Ω 3W
R20 15K 3W
C-11 100
T-1 MT7FB
T-2 MT7FB
J-1
TERM
INPUT
BRIDG
J-2
C-1
C-12
C-13
R-22
2mfd 600 1%
R-1 10K
C-2
P-2
R-2 10K
R-3 220K
R-4 470
R-5 4.7K
C-3 20 mfd 25V
R-6 27K
R-7 1MEG
C-4 .01
R-8 390
R-9 10K
Q-1
Q-2
M
R-10 4.7K
C-5 .1
C-6 .1
R-11 2K
R-12 27K
R-13 1MEG
R-14 200
C-8 20 MFD 25V
R-15 200
R-16 10K
Q-3
C-7 .1
BL
G
R
CR-2 CR-3
CR-4 CR-5 CR-6 CR-7
R-17 11K
CR-8
CR2 1056 K-1
Q-4
R-19 1K, 3W
R-18 1K, 3W
C-10 .1 UFD
GND
P.C. BOARD
J-3
TO TTS-26 REC LOOP
OUTPUT
MON
J-4
1
2
3
4
5
6
PL1
OPERATE
S-3
CAL.
ALL DIODES ARE IN2069
ALL TRANSISTORS ARE 2N1375
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS ±1/64 DECIMALS ±.005 ANGLES ±½°
ALL SURFACES
MATERIAL
FINISH
PAINT
SCREEN PER
DRAWN J.C. JOHNSON
DATE APRIL 17, 1964
APPD
ISSUED
APPROVED DATE
ENGR
MFG
MATL
SCALE
WT CALC ACTUAL
SCHEMATIC
DETECTOR SECTION
TTS-26BXS-1
NORTHEAST ELECTRONICS CORP.
CONCORD, N. H.
REF. NO. B-1138X
SIZE B
40456
CONT ON SHEET
SH NO

FIG. 2



NOTES:

① SELECTED VALUE, VALUES SHOWN ARE APPROXIMATE.

② THIS CHANGE TO BE MADE ON TTS-562.

REV. 1 ADDED S-4

FIG. -3

MODEL TTS-26BXS-1
OSCILLATOR SECTION

TABLE OF REPLACEABLE PARTS

Circuit Ref	Description	Mfr* & Mfr's Designation
	OSCILLATOR SECTION	
R1	Resistor: fixed, wirewound, 600 ohms ±5%, 3 w	M, 242E6015
R2	Resistor: fixed, wirewound, 2.0 K ±5%, 3 w	M, 242E2025
R3	Resistor: fixed, composition, 330 ohms ±10%, ½ w	A, RC20
C1	Capacitor: fixed, electrolytic, 100 mfd, 50 vdc	G, APD-127
C2	Capacitor: fixed, paper, 20 mfd, 150 vdc	M 121P2
S1	Switch: rotary (FREQ SELECTOR), for resistor values see schematic	B, PA2011
S2	Switch: rotary (ATTEN) for resistor values see schematic	B, PA1005
S4	Switch: key (PULSE, OFF HOOK, ON HOOK)	N, 173N
T1	Transformer: OUTPUT	R, S-58X
J1	Jack: (OSC OUTPUT)	O, 12B
J2	Jack: (TO TTS 26B SEND LOOP)	O, 12B
	(The following parts are contained on Printed Circuit Board NEC-E95022)	
R1	Resistor: fixed, composition, 47 K ±10%, ½ w	A, RC20
R2	Resistor: fixed, composition, 10 K ±10%, ½ w	A, RC20
R3	Resistor: fixed, composition, 3.3 K ±10%, ½ w	A, RC20
R4	Resistor: fixed, composition, 220 ohms ±10%, ½ w	A, RC20
R5	Resistor: fixed, variable, wirewound, 400 ohms	C, CM22425NP
R6	Resistor: fixed, composition, 1.5 K ±10%, ½ w	A, RC20
R7	Resistor: fixed, composition, 30 K ±5%, ½ w	A, RC20
R10	Resistor: fixed, composition, 100 K ±10%, ½ w	A, RC20
R11	Resistor: fixed, composition, 100 K @10%, ½ w	A, RC20
R12	Resistor: fixed, composition, 10 K ±10%, ½ w	A, RC20
R13	Resistor: fixed, composition, 220 K ±10%, ½ w	A, RC20
R14	Resistor: fixed, composition, 2.2 K ±5%, ½ w	A, RC20
C1	Capacitor: fixed, electrolytic, 20 mfd, 25 vdc	G, APD-046
C2	Capacitor: fixed, electrolytic, 20 mfd, 25 vdc	G, APD-046
C3	Capacitor: fixed, paper, .0096 mfd, 100 vdc	M, 194P96251
C4	Capacitor: fixed, paper, .0096 mfd, 100 vdc	M, 194P96251
C5	Capacitor: fixed, electrolytic, 20 mfd, 25 vdc	G, APD-046
C6	Capacitor: fixed, electrolytic, 20 mfd, 25 vdc	G, APD-046
C7	Capacitor: fixed, electrolytic, 20 mfd, 25 vdc	G, APD-046
L1	Lamp: (A-10 327)	F, T4½
Q1	Transistor: PNP	Q, 2N1375
Q2	Transistor: PNP	Q, 2N1375
Q3	Transistor: PNP	Q, 2N1375
Q4	Transistor: PNP	Q, 2N1375
TTS562	Oscillator Keyer: Complete	K, TTS 562
	DETECTOR SECTION	
R1	Resistor: variable, carbon, 10 K	L, CU-1031
R2	Resistor: fixed, composition, 10 K ±10%, ½ w	A, RC20
R3	Resistor: fixed, composition, 220 K ±10%, ½ w	A, RC20

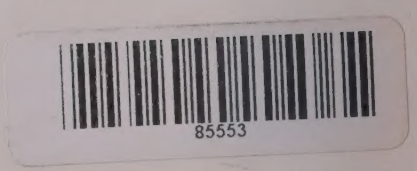
TABLE OF REPLACEABLE PARTS

Circuit Ref	Description	Mfr* & Mfr's Designation
	DETECTOR SECTION	
R4	Resistor: fixed, composition, 470 ohms ±5%, ½ w	A, RC20
R5	Resistor: fixed, composition, 4.7 K ±10%, ½ w	A, RC20
R6	Resistor: fixed, composition, 27 K ±10%, ½ w	A, RC20
R7	Resistor: fixed, composition, 1 meg ±10%, ½ w	A, RC20
R8	Resistor: fixed, composition, 390 ohms ±10%, ½ w	A, RC20
R9	Resistor: fixed, composition, 10 K ±10%, ½ w	A, RC20
R10	Resistor: fixed, composition, 4.7 K ±10%, ½ w	A, RC20
R11	Resistor: fixed, composition, 2.0 K ±5%, ½ w	A, RC20
R12	Resistor: fixed, composition, 27 K ±10%, ½ w	A, RC20
R13	Resistor: fixed, composition, 1 meg ±10%, ½ w	A, RC20
R14	Resistor: fixed, composition, 200 ohms ±5%, ½ w	A, RC20
R15	Resistor: fixed, composition, 200 ohms ±5%, ½ w	A, RC20
R16	Resistor: fixed, composition, 10 K ±10%, ½ w	A, RC20
R17	Resistor: fixed, composition, 11 K ±5%, ½ w	A, RC20
R18	Resistor: fixed, wirewound, 1 K ±5%, ½ w	A, RC20
R19	Resistor: fixed, wirewound, 1 K ±5%, 3 w	M, 242E1025
R20	Resistor: fixed, wirewound, 1.5 K ±5%, 3 W	M, 242E1525
R21	Resistor: fixed, wirewound, 500 ohms ±5%, 3 w	M, 242E5015
R22	Resistor: fixed, 600 ohms ±1%, ½ w	H, CEC-TO
C1	Capacitor: fixed, .1 mfd, 75 vdc	B, DDA104
C2	Capacitor: fixed, .1 mfd, 75 vdc	B, DDA104
C3	Capacitor: fixed, electrolytic, 20 mfd, 25 vdc	G, ADP-046
C4	Capacitor: fixed, .01 mfd, 600 vdc	B, ID-01
C5	Capacitor: fixed, .1 mfd, 75 vdc	B, DDA104
C6	Capacitor: fixed, .1 mfd, 75 vdc	B, DDA104
C7	Capacitor: fixed, .1 mfd, 75 vdc	B, DDA104
C8	Capacitor: fixed, electrolytic, 20 mfd, 25 vdc	G APD-046
C10	Capacitor: fixed, .1 mfd, 75 vdc	B, DDA104
C11	Capacitor: fixed, electrolytic, 100 mfd, 50 vdc	G, APD-127
C12	Capacitor: fixed, .1 mfd, 75 vdc	B, DDA104
C13	Capacitor: fixed, paper, 2.0 mfd, 150 vdc	M, 121P2
T1	Transformer	J, MT7FB
T2	Transformer	J, MT7FB
J1	Jack: (TERM)	O, 12B
J2	Jack: (BRIDGE)	O, 54-SF
J3	Jack: (TO REC LOOP)	O, 12B
J4	Jack: (MON)	O, 12B
P1-1	Lamp	E, 105-4428-722
CR1-CR8	Diodes	P, 1N2069
Q1	Transistor	Q, 2N1375
Q2	Transistor	Q, 2N1375
Q3	Transistor	Q, 2N1375
Q4	Transistor	Q, 2N1375
S3	Switch: (OPERATE-CAL)	O, 4009
R1	Relay: Reed Type, SPST	C, CRZ-1056T
	Knob: (2 per set)	I, 647-3L-BB
	Knob	I, 645-3L-BB

*See List of Manufacturers Code Letters for Replaceable Parts Table

LIST OF MANUFACTURERS CODE LETTERS

Code	Manufacturer
A	Allen-Bradley Company
B	Centralab Electronics
C	C. P. Clare and Company
D	Clarostat Manufacturing Company
E	Dialight Corporation
F	Herzog Miniature Lamp Works, Inc.
G	International Electronic Industries, Inc.
H	IRC, Inc.
I	Kurz-Kasch, Inc.
J	Microtran Company, Inc.
K	Northeast Electronics Corporation
L	Ohmite Manufacturing Company
M	Sprague Electric Company
N	Stromberg-Carlson Company
O	Switchcraft, Inc.
P	Sylvania Electric Products, Inc.
Q	Texas Instruments, Inc.
R	Triad Transformer Corporation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